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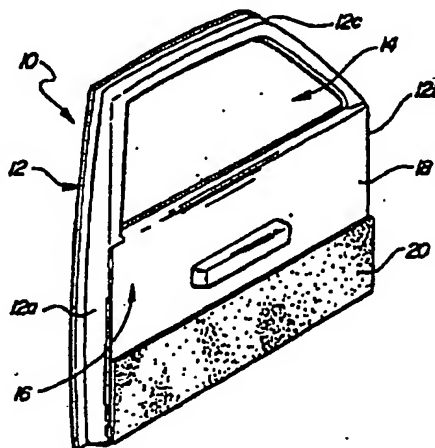
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(54) Title: CARPET AND METHOD OF ATTACHMENT



(57) Abstract

An improved carpet, an improved method of making a carpet, and an improved method of attaching a carpet to a motor vehicle door trim panel. The improved carpet (20) comprises an outer woven polypropylene pile layer (22), an inner nonwoven polypropylene layer (24), and a central intermediate recycled rubber layer (26). The carpet is formed by extruding a melted mixture of rubber and polypropylene particles to form a hot central sheet (26) and thereafter adhering a woven polypropylene layer to the upper face of the hot sheet and a nonwoven polypropylene layer to the lower face of the hot sheet. Carpet is attached to the lower portion of a door trim panel (18) of a motor vehicle by heating the lower portion of the door trim panel with hot air until the panel is tacky and thereafter pressing the invention carpet downwardly against the tacky surface of the door trim panel to form a firm welded marriage as between the carpet and the panel. Alternatively, the marriage of the carpet and panel may be achieved by ultrasonic energy applied through the door trim panel to the interface between the door trim panel and the carpet.

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CARPET AND METHOD OF ATTACHMENT

This invention relates to fabrics and more specifically to fabrics employed in trim applications for motor vehicles, particularly carpeting intended to be
5 attached to the lower surface of door trim panels.

Trim or decorative fabrics are utilized in many locations in modern day passenger car motor vehicles. For example, carpeting is applied to the floor of the vehicle in the front and/or rear passenger compartment;
10 carpeting is utilized to cover the floor of the trunk; and carpeting is attached to the lower portions of the door trim panels. In each of these applications, it is imperative that the carpet be applied to the substrate panel in an inexpensive and effective manner consistent
15 with modern day motor vehicle mass assembly procedures and it is further extremely important that the carpeting remain affixed to the underlying substrate panel even in extreme conditions of temperature and wear and even over-extended periods of usage. Prior art methods of
20 attaching carpet trim to interior substrate panels of motor vehicles include the use of glues, the use of staples, the use of a pressure sensitive backing for the carpet, and the use of sonic welding techniques. Each of these prior art techniques or methods present problems.
25 The use of glues is labor intensive, is done at the risk of excess glue contaminating other areas of the motor vehicle, creates environmental problems including the

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need to dispose of the empty glue cans and the need to use solvents to clean the gluing equipment, and creates warranty problems since the glued carpeting often comes loose from the substrate panel under conditions of hard
5 usage and/or extreme temperature conditions. The use of staples is labor intensive, is unsightly since the staples often show and detract from the aesthetics of the final carpet assembly, can result in weakening or even fracturing of the substrate panel, and creates warranty
10 problems since the staples often work loose under extreme conditions with resultant loosening of the carpeting. The use of a pressure sensitive backing on the carpeting adds significantly to the cost of the carpet and creates significant warranty problems since the pressure
15 sensitive backing cannot tolerate extreme usage or temperature conditions. The use of sonic welding techniques creates aesthetic problems since the sonic welding often produces burn spots on the carpeting.

Summary of the Invention

20 This invention is directed to the provision of an improved decorative fabric, and an improved method of attaching the decorative fabric to a substrate panel.

 More specifically, this invention is directed to the provision of an improved method of attaching a
25 carpet fabric to substrate surfaces in motor vehicles.

 Yet more specifically, this invention is directed to the provision of an improved method of

attaching carpet strips to the lower portions of door trim panels in motor vehicles.

The invention broadly provides a method of providing a substrate panel and fabric assembly.

5 According to the invention method, a rigid substrate panel is provided formed of a fusible material; a fabric member is provided having an aesthetic material layer on one surface thereof and a heat fusible backing material layer at another surface thereof; the fabric member is

10 positioned proximate the substrate panel with the heat fusible surface of the fabric member juxtaposed to one surface of the substrate panel; heat is provided at the interface of the substrate panel and the fabric member sufficient to fuse the backing material on the fabric and

15 the material of the panel at their interface; and the fabric member is pressed against the substrate panel to fuse the fabric member to the panel and form the substrate panel and fabric assembly. This basic methodology provides an inexpensive and effective way of

20 attaching the fabric to the substrate.

According to a further feature of the invention methodology, the heat providing step comprises applying heat to the one surface of the panel to render the one surface tacky and thereafter positioning the fabric

25 member proximate the panel with the heat fusible surface of the fabric member juxtaposed to the one surface of the substrate panel, and the pressing step comprises pressing the fabric member against the tacky surface of the panel.

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This simple methodology provides a solid fusion as between the fabroc member and the substrate panel.

According to a further feature of the invention methodology, a third layer is provided for the fabric member comprising an elastomeric material layer positioned in sandwich fashion between the aesthetic material layer and the backing material layer. This intermediate layer of elastomeric material facilitates the attachment of the aesthetic layer to the backing material layer and facilitates the fusion process.

In the disclosed embodiment of the invention, the backing material comprises a nonwoven polypropylene material. The nonwoven polypropylene material readily fuses and readily bonds to the confronting surface of the substrate panel.

According to a further aspect of the invention methodology, the fabric member is a carpet member; the carpet member is placed against the substrate panel; the carpet member is moved to a position removed from the panel; an area of the panel is locally heated; the carpet member is returned to a position contiguous to the heated area of the panel; and the carpet member is pressed against the panel to fuse the carpet member to the panel at their interface. This specific handling of the panel and carpet allows the attachment process to be performed with a minimum of labor and in a minimum time frame.

According to a further aspect of the invention methodology, the panel is heated by the application of hot air to the local portion of the panel. This specific heating arrangement facilitates the inexpensive heating 5 of the panel to accomplish the fusion operation as between the carpet member and the panel.

According to another, alternate aspect of the invention methodology, the heat is provided at the interface of the substrate panel and the carpet member by 10 delivering sonic energy to the interface so as to generate heat by the vibration of the carpet material and the confronting material of the panel.

The invention also provides a method of forming a laminar fabric such as a carpet. According to this 15 aspect of the invention method, a heated fused mixture of material is provided; the heated mixture is extruded to form a hot layer or sheet of material; and a layer of carpeting material is applied to one surface of the hot layer of material. This arrangement provides an 20 inexpensive and effective means of providing a carpet especially suitable for attachment to a substrate.

According to a further feature of the carpet forming method, a second layer of carpet is applied to the other surface of the hot layer to form a sandwich 25 structure for the carpet.

In the disclosed embodiment of this aspect of the invention, the mixture of material forming the hot layer comprises a mixture of rubber particles and

polypropylene particles, one layer of carpeting material comprises a pile layer of woven polypropylene material, and the other layer of carpeting material comprises a layer of nonwoven polypropylene material.

5 The invention also provides a novel carpet structure. The carpet structure according to the invention comprises an upper pile layer of woven polypropylene material; an intermediate layer of elastomeric material; and a lower layer of nonwoven
10 polypropylene material. This particular carpet construction provides a carpet that is particularly amenable to attachment to a substrate.

Brief Description of the Drawings

FIGURE 1 is a perspective simplified view of a
15 door assembly of a motor vehicle;

FIGURE 2 is a perspective view of a door trim panel assembly utilized in the door assembly of Figure 1;

FIGURE 3 is a schematic view of the composition of a carpet member utilized in the door trim panel
20 assembly of Figure 2;

FIGURE 4 is a schematic view showing a method of forming a carpet member of the type shown schematically in Figure 3;

FIGURE 5 is a cross-sectional view taken within
25 the circle 5 of Figure 4;

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FIGURE 6 is a schematic perspective view showing a method of forming the trim panel assembly of Figure 2;

FIGURES 7-9 are detailed views of a heating device employed in the method of Figure 6; and

FIGURES 10-13 disclose an alternate method of forming the door trim panel of Figure 2.

Detailed Description of the Preferred Embodiments

The motor vehicle door assembly shown in Figure 10 includes a metal frame structure 12, a window 14, and a trim panel assembly 16.

Frame 12 includes a shut face 12a, a hinge face 12b, and an upper window frame portion 12c framing window 14.

15 Window 14 is positioned in its raised position within window frame portion 12c and is lowerable in known manner by a crank mechanism (not shown) to a stowed position within door frame 12.

Door trim panel assembly 16 includes a door 20 trim panel 18 and a fabric member such as a carpet strip 20 secured to the lower portion of the door trim panel.

Door trim panel 18 has a size, shape and configuration varying with the particular motor vehicle with which it is associated and in general covers the 25 area of the door frame 12 on the inside of the motor vehicle below the opening defined by the window frame portion 12c. Trim panel 18 is preferably formed of a

polypropylene material but may also be formed of other materials such for example as ABS plastic.

Carpet strip 20 includes an outer aesthetic material layer such as a pile layer 22, a heat fusible inner backing layer 24, and an intermediate backing layer 26. Outer pile layer 22 is preferably formed of a woven polypropylene material; inner backing layer 24 is preferably formed of a nonwoven polypropylene material; and intermediate layer 26 is preferably formed of an elastomeric material such for example as a mixture of fused rubber particles and polypropylene particles. Recycled rubber is particularly suitable for use in forming intermediate layer 26.

As seen schematically in Figure 4, carpet strip 20 may be formed by mixing a supply of polypropylene pellets or powder 28 and a supply of recycled rubber pellets or powder 30 in a container 32, heating the container to form a fused melted mixture of polypropylene and rubber, supplying the fused mixture to the hopper 34 of an extruder 36, extruding a sheet or hot layer 26 from the extruder 36 by the use of an extruder piston 38, passing the hot layer 26 through heated nipper rollers 40, 42 and thereafter upwardly around roller 42, unrolling a layer or sheet of nonwoven polypropylene material 24 from a roll of nonwoven polypropylene material 44 and passing the sheet 24 between nipper roller 42 and a further nipper roller 46 to press the sheet 24 into the hot and fusible under face of layer 26,

and passing a sheet or layer 22 of woven polypropylene material from a roll 48 of woven polypropylene material around a pressure roll 50 and into contact with the upper face of layer 38 to bond the sheet 22 to the hot fused 5 upper face of layer 26 so as to form the sandwich or laminar carpet structure shown schematically in Figure 3 and shown structurally in Figure 5.

As seen in Figure 5, the invention carpet strip 20, as formed by the method of Figure 4, includes a fused 10 laminar structure in which the melted fibers of the woven polypropylene layer 26 have fused into the hot elastomeric layer 26 and the fused or melted fibers of nonwoven polypropylene layer 24 have fused into the lower face of the hot elastomeric layer 26 to form the carpet 15 strip 20. The carpet 20 thus formed is secured to the door trim panel 18 by the method seen schematically in Figure 6.

In the method of forming a trim panel assembly shown in Figure 6, the door trim panel 18 is preferably 20 formed of a polypropylene material. In Figure 6a, door trim panel 18 is shown supported on a fixture or nest 56 located at a first work station A and a carpet strip 20 is positioned on the upper or outer face 18a of the door trim panel.

25 In Figure 6b, carpet strip 20 has been suitably raised above the level of the door trim panel 18 (as for example by the use of a suction device) and the nest 56, carrying door trim panel 18, has been suitably shuttled

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(by a mechanism not shown) to a second work station B where the lower portion 18b of the upper surface 18a of the door trim panel underlies a hot air heating device 58.

5 Hot air heating device 58, as best seen in Figures 7-9, includes an outer frame structure 60 of generally rectangular construction open at its lower end; a hood 62 positioned within the outer frame 60; a conduit 64 connected to a suitable source of air and opening at
10 its lower end 64a at the upper end of hood 62; two or more rods 66 extending in parallel fashion between frame end wall 60a and 60b and passing through hood 62; and leads 68 suitably connected to rods 66 so as to heat the rods in known manner. Rods 66 may for example be of the
15 Kalrod type available from Tempco Inc. of Woodale, Illinois. It will be understood that air delivered through conduit 64 passes downwardly over heated rods 66 so as to provide a supply of heated air at the open lower end of hood 62.

20 As seen in Figure 6c, the heated air emerging from the open lower end of hood 62 of heater 58 impinges on the upper face 18a of trim panel 18 in the lower region 18b of the panel so as to locally heat the panel over the area 18b and produce a tacky, fused surface
25 condition over the local area 18b, whereafter, as seen in Figure 6d, the nest 56 and panel 18 carried thereby are returned to work station A to position panel 18 in a position directly underlying carpet strip 20, whereafter,

as seen in Figure 6e, the carpet strip 20 is lowered to a position where its underface is in juxtaposition to the tacky surface 18b of the panel, whereafter a suitable platen 70 is moved into position over the carpet to press the carpet downwardly against the tacky surface 18b of the panel. As the carpet is pressed against the hot tacky surface 18b, fibers of the elastomeric layer 26 and the nonwoven polypropylene layer 24 are heated by the heat from the tacky surface of the panel, fuse together, and melt or blend into the tacky surface 18b of the panel to form a solid, fused weld as between the carpet and the panel consisting of melted fibers of carpet layers 24 and 26 and melted fibers of the polypropylene panel 18.

An alternate method for attaching carpet strips 15 to door trim panels is shown in Figures 10-13. The method of Figures 10-13 is especially suitable for use with door trim panels of the type formed of ABS plastic material.

In the method seen in Figures 10-13, carpet strip 20 is suitably supported on a nest or fixture 62 with nonwoven layer 22 uppermost; door trim panel 18 is positioned over carpet strip 20 with surface 18b of the panel contiguous to carpet nonwoven layer 22; and a sonic welding head 80 is suitably positioned over the lower portion of panel 18.

Welding head 80 includes a main frame portion 82 and a plurality of horns 84 projecting downwardly from main frame 82 for engagement with the rear face of the

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door trim panel 18 at longitudinally and laterally spaced locations so as to form a matrix with respect to the lower portion of the door trim panel. Sonic welder 80 is suitably energized in known manner to vibrate the horns 5 84 and the horns 84 operate through panel 18 to create vibration at respective local locations at the interface between the carpet 20 and the panel 18 so as to heat the panel 18 and the carpet 20 at the local vibration points and fuse the carpet to the panel at these points.

10 Specifically, the vibration at the local interface points has the effect of melting the material of elastomeric intermediate layer 26, fusing the fibers of nonwoven polypropylene layer 22 into elastomeric layer 26, fusing the material of panel 18, and fusing the intermixed

15 material of layers 22 and 26 in a welding manner to the fused surface of panel 18 to form a tight, irrevocably sonic marriage as between the carpet 20 and the panel 18.

The invention will be seen to provide an improved carpet assembly, an improved method for forming

20 a carpet assembly, and an improved method of attaching a carpet strip to a door trim panel of a motor vehicle in a manner to avoid aesthetic marring of the carpet strip and yet provide a firm welded attachment of the strip to the panel that will endure sustained heavy usage as well

25 as temperature extremes.

Whereas preferred embodiments of the invention have been illustrated and described in detail, it will be apparent that various changes may be made in the

disclosed embodiments without departing from the scope or spirit of the invention.

Claims

1. A method of providing a substrate panel and fabric assembly comprising the steps of:

A) providing a rigid substrate formed of a
5 fusible material;

B) providing a fabric member having an
aesthetic material layer at one surface thereof and a
heat fusible backing material layer at another surface
thereof;

10 C) positioning said fabric member proximate
said substrate panel with said other surface of said
fabric member juxtaposed to one surface of said substrate
panel;

D) providing heat at the interface of said
15 substrate panel and said fabric member sufficient to fuse
said backing material and said panel at said interface;
and

E) pressing said fabric member against said
substrate panel to fuse said fabric member to said panel
20 and form said substrate panel and fabric assembly.

2. A method according to claim 1 wherein:

F) said heat providing step comprises applying
heat to said one surface of said panel to render said one
surface tacky and thereafter positioning said fabric
25 member proximate said panel with said other surface of

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said fabric member juxtaposed to said one surface of said substrate panel; and

G) said pressing step comprising pressing said fabric against said tacky surface of said panel.

5 3. A method according to claim 1 wherein:

F) said heat providing step comprises delivering sonic energy to said interface.

4. A method according to claim 1 wherein said method includes the further step of:

10 F) providing a third layer for said fabric member comprising an elastomeric material layer positioned in sandwich fashion between said aesthetic material layer and said backing material layer.

5. A method according to claim 4 wherein:

15 G) said backing material layer comprises a nonwoven polypropylene material.

6. A method of attaching a carpet member to a rigid substrate panel comprising the steps of:

A) placing the carpet member in juxtaposition
20 to the panel;

B) moving the carpet member to a position removed from the panel;

C) locally heating an area of the panel;

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D) returning the carpet member to a position contiguous to the heated area of the panel; and

E) pressing the carpet member against the panel to fuse the carpet member to the panel at their interface.

7. A method according to claim 6 wherein:

F) said carpet member is a laminar structure comprising a woven polypropylene pile upper layer, a nonwoven polypropylene lower layer, and an elastomeric intermediate layer sandwiched between said upper and lower layers.

8. A method of forming a laminar fabric material comprising the steps of:

A) providing a heated mixture of material;
15 B) extruding the material to form a hot layer of material; and
C) applying a layer of aesthetic material to one surface of the hot layer.

9. A method according to claim 8 including the 20 further step of:

D) applying a second layer of heat fusible material to the other surface of the hot layer to form a sandwich structure.

10. A method according to claim 8 wherein:

D) said mixture of material comprises rubber particles and polypropylene particles.

11. A method according to claim 10 wherein:

E) said layer of aesthetic material comprises
5 a pile layer of woven polypropylene material.

12. A method according to claim 10 wherein:

E) said layer of heat fusible material
comprises a layer of nonwoven polypropylene material.

13. A method according to claim 10 wherein:

10 E) said mixture of material comprises rubber
particles and polypropylene materials;

F) said layer of aesthetic material comprises
a pile layer of woven polypropylene material; and

G) said layer of heat fusible material
15 comprises a layer of nonwoven polypropylene material.

14. A method of attaching a carpet strip to
the lower portion of a motor vehicle door trim panel
formed of a fusible material, said method comprising the
steps of:

20 A) providing a heat fusible material on one
surface of the carpet strip;

B) positioning the carpet strip proximate the
door trim panel with said one surface of the carpet strip
juxtaposed to one face of the door trim panel;

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- C) providing heat at the interface of the carpet strip and the door trim panel sufficient to fuse said one face of the door panel and the heat fusible material on said surface of the carpet strip; and
- 5 D) pressing the carpet strip against the door trim panel to fuse the carpet strip to the door trim panel.

15. A method according to claim 14 wherein:

- E) said heat providing step comprises applying
- 10 heat to the upper face of the door trim panel to render that surface tacky and thereafter positioning the carpet strip proximate the door trim panel with the underface of the carpet strip juxtaposed to the upper face of the door trim panel; and
- 15 F) said pressing step comprises pressing the carpet strip against the tacky upper face of the door trim panel.

16. A method according to claim 15 wherein:

- G) prior to said positioning step the carpet
- 20 strip is positioned proximate the door trim panel at a first work station, the carpet strip is moved away from the door trim panel, the door trim panel is shuttled to another work station where heat is applied to one face of the door trim panel, and the heated door trim panel is
- 25 returned to the first work station where said positioning step is performed by moving the carpet strip against the

heated surface of the door trim panel whereafter said pressing step is performed.

17. A carpet comprising:

A) an upper pile layer of woven polypropylene material;

B) an intermediate layer of elastomeric material; and

C) a lower layer of nonwoven polypropylene material.

10 18. A carpet according to claim 17 wherein:

D) said intermediate layer comprises a fused mixture of rubber and polypropylene particles.

19. A carpet according to claim 18 wherein:

E) said carpet is formed by preparing a
15 mixture of elastomeric and polypropylene particles, melting said particles to form a fused mixture, extruding said mixture to form a hot elastomeric layer, and attaching said upper woven layer and said lower nonwoven layer respectively to the opposite faces of said hot
20 layer.

20. A method according to claim 2 wherein:

H) said heat providing step comprises blowing hot air onto said one surface of said panel.

21. A method according to claim 6 wherein:

F) the carpet member is placed on the panel at
a first work station;

G) the carpet member is raised to a position
5 above the panel whereafter the panel is shuttled to a
second work station;

H) the local heating of the panel takes place
at the second work station whereafter the locally heated
panel is returned to the first work station whereafter
10 the carpet member is lowered to a position contiguous to
the heated area of the panel.

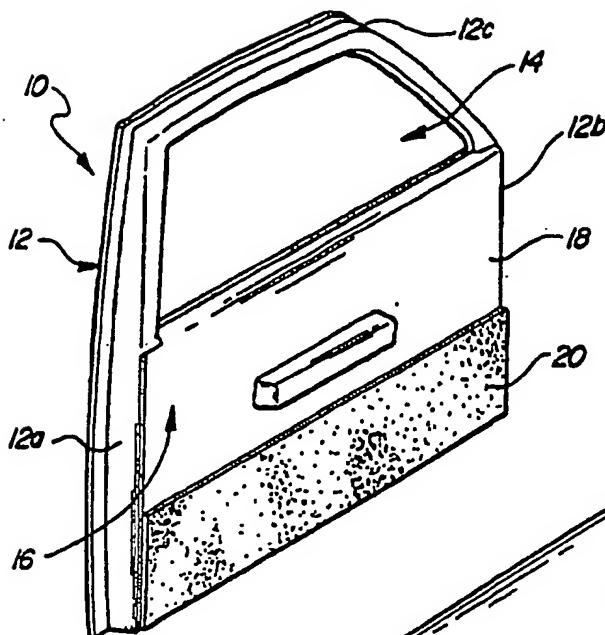


FIG - 1

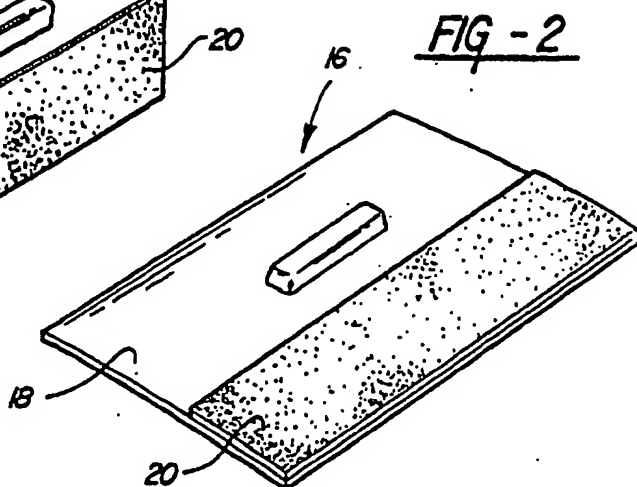


FIG - 2

FIG - 3

22	WOVEN POLYPROPYLENE FIBRE
26	RECYCLED RUBBER
24	NON-WOVEN POLYPROPYLENE

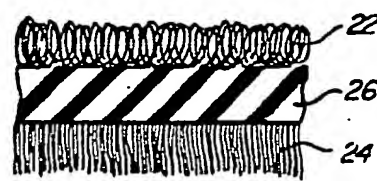


FIG - 5

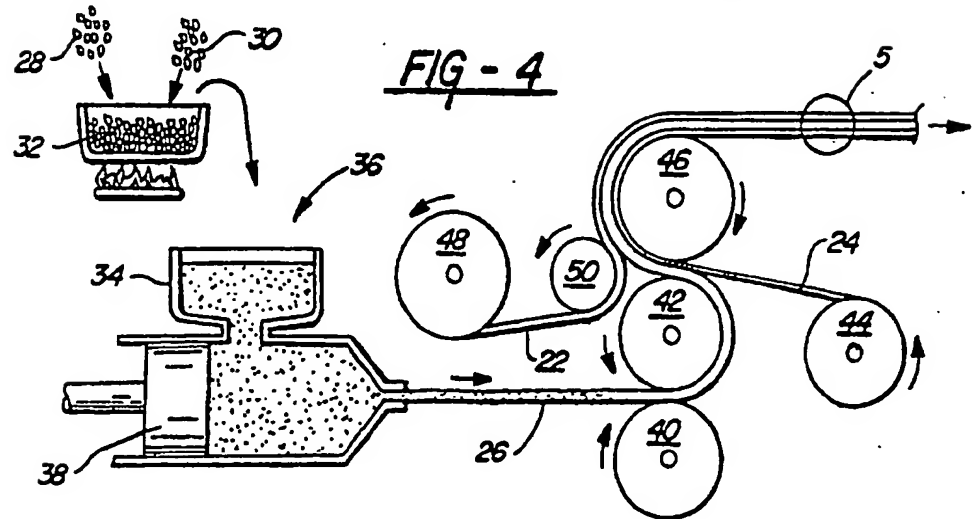
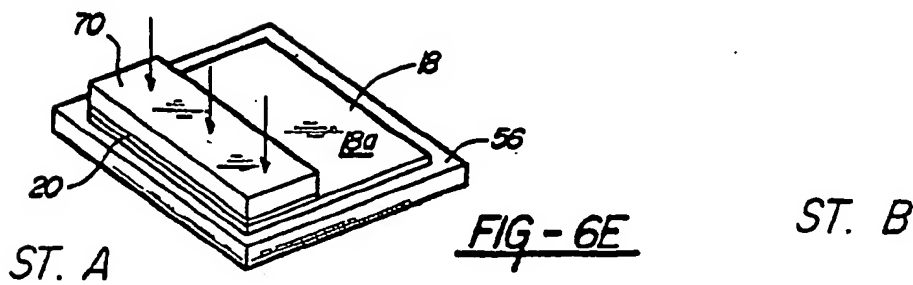
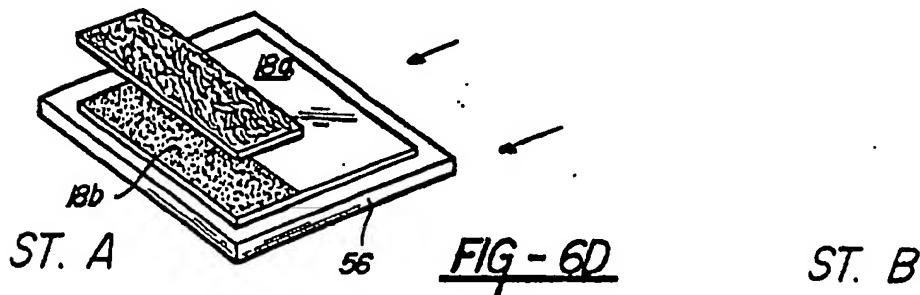
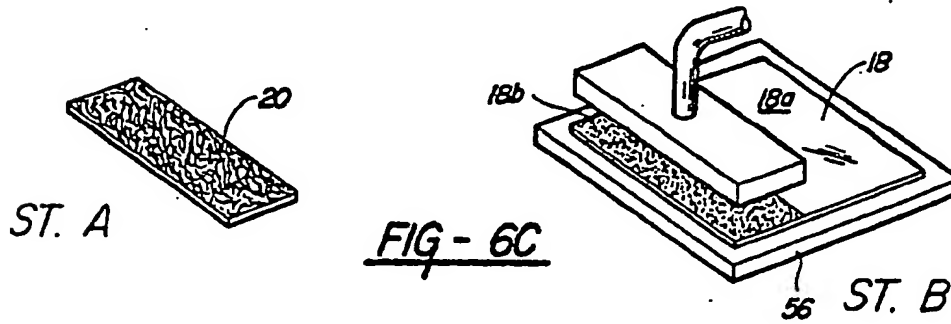
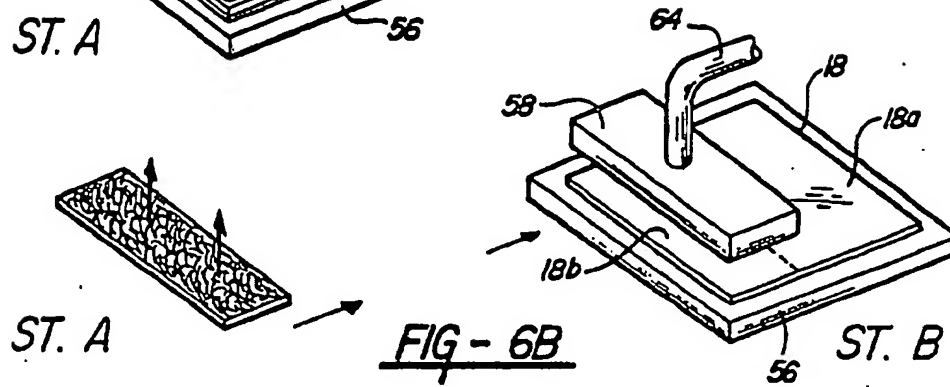
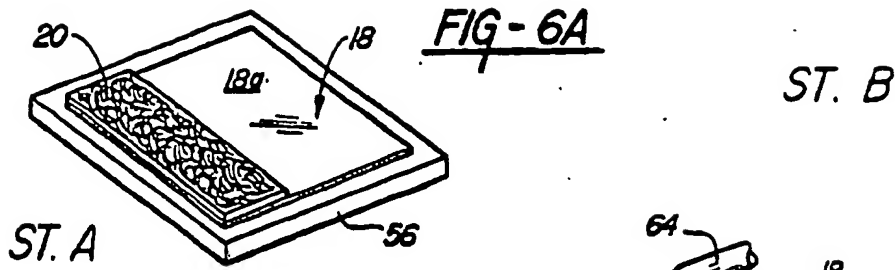


FIG - 4



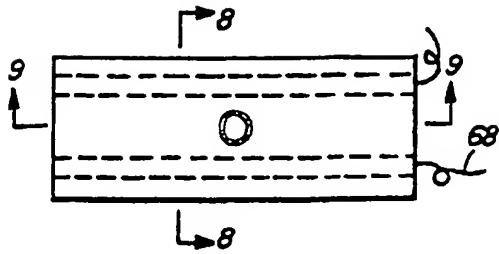


FIG - 7

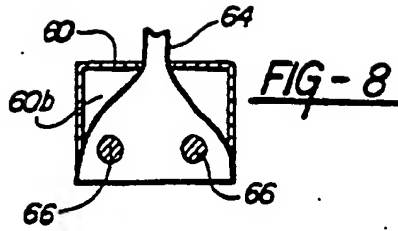


FIG - 8

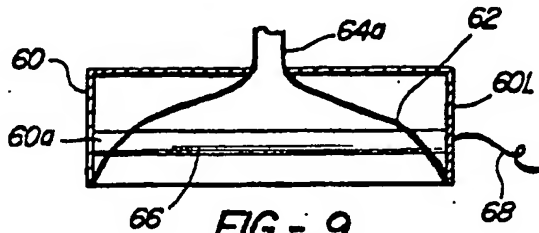


FIG - 9

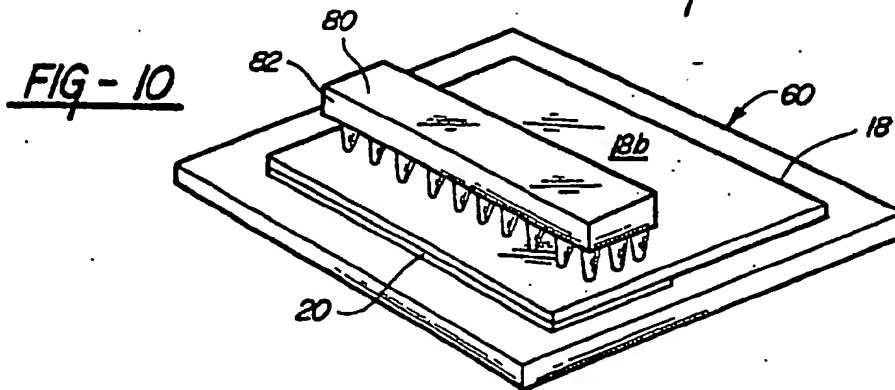


FIG - 10

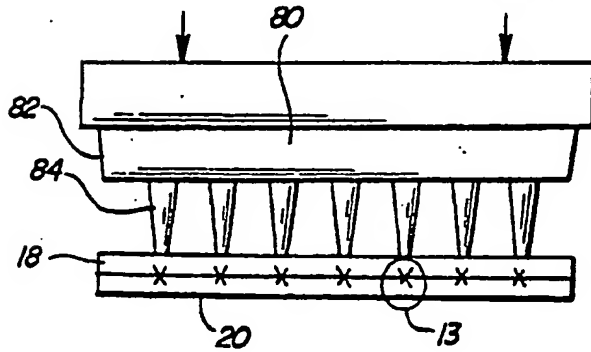


FIG - 11

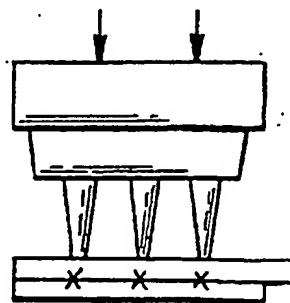


FIG - 12

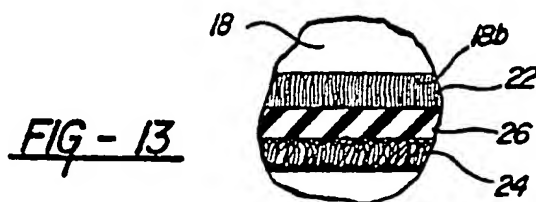


FIG - 13

I. CLASSIFICATION OF SUBJECT MATTER (If several classification symbols apply, indicate all) *		
According to International Patent Classification (IPC) or to both National Classification and IPC IPC CL. (5): B28 31/16 U.S. CL.: 156/73.1; 156/152; 156/244.27; 156/309.9; 156/321; 156/322; 156/324.4; 296/39.1; 296/191; 428/95		
II. FIELDS SEARCHED		
Minimum Documentation Searched *		
Classification System	Classification Symbols	
U.S.	156/73.1; 152; 244.27; 309.9; 321; 322; 324.4; 296/39.1; 191 428/95	
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched *		
III. DOCUMENTS CONSIDERED TO BE RELEVANT **		
Category *	Citation of Document, ** with indication, where appropriate, of the relevant passages **	Relevant to Claim No. **
X	DE, A, 2,727,285 (GENTLE) 12 January 1978, see english translation abstract and in english translation: page 1 lines 8-10 and 22-23, page 2 lines 1-23.	8-13, 17-19
X Y	JP, A, 62-227,811 (USUI ET AL.) 06 October 1987, see english translation abstract and in english translation: page 1 line 3 thru page 2 line 3, page 3 line 13 thru page 4 line 2, page 5 lines 6-8 and 15-19, page 6 lines 1-4 and 8-18, page 7 lines 8-14.	1-2, 4-5, 14-15 3, 6-7, 16, 20-21
Y	GB, A, 1,018,370 (BRANSON) 26 January 1966, see page 1 lines 11-25, page 2 lines 20-34, page 4 lines 24-31.	3
<p>* Special categories of cited documents: **</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubt on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art</p> <p>"A" document member of the same patent family</p>		
IV. CERTIFICATION		
Date of the Actual Completion of the International Search *		Date of Mailing of this International Search Report *
13 SEPTEMBER 1990		10 DEC 1990
International Searching Authority *		Signature of Authorized Officer **
ISA/US		J. J. GALLAGHER

FURTHER INFORMATION CONTINUED FROM THE SECOND SHEET

Y	US, A, 3,788,917 (LINDA) 29 January 1974, see abstract, col. 1 lines 56-58, col. 3 lines 24-32.	20
Y	US, A, 2,554,150 (MOORE) 22 May 1951, see fig. 1, col. 1 lines 1-4, col. 2 lines 15-21, col. 3 lines 3-8 and 50-53, col. 4 lines 22-27, col. 5 lines 30-35 and 60-66.	6-7,16,21

V. ☐ OBSERVATIONS WHERE CERTAIN CLAIMS WERE FOUND UNSEARCHABLE¹

This International search report has not been established in respect of certain claims under Article 17(2) (a) for the following reasons:

1. ☐ Claim numbers _____, because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claim numbers _____, because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out², specifically:
3. ☐ Claim numbers _____, because they are dependent claims not drafted in accordance with the second and third sentences of PCT Rule 6.4(a).

VI. ☐ OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING³

This International Searching Authority found multiple inventions in this international application as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims of the international application.
2. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims of the international application for which fees were paid, specifically claims:
3. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claim numbers:
4. ☐ As all searchable claims could be searched without effort justifying an additional fee, the International Searching Authority does not invite payment of any additional fee.

Remark on Protest

- ☐ The additional search fees were accompanied by applicant's protest.
- ☐ No protest accompanied the payment of additional search fees.

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